A READINESS FOR INNOVATION SURVEY OF INDONESIAN SMEs IN THE METAL SECTOR

Kifayah Amar

Department of Industrial Engineering

Faculty of Science and Technology, UIN Sunan Kalijaga, Indonesia

Kifayah.Amar@eng.uts.edu.au

Douglas Davis

Faculty of Business, University of Technology, Sydney

PO Box 123, NSW 2007

doug.davis@uts.edu.au

A READINESS FOR INNOVATION SURVEY OF INDONESIAN SMEs IN THE METAL SECTOR

ABSTRACT

This paper reports key results from research aimed at developing a framework to introduce Lean Six Sigma into Indonesian SMEs operating in the metal industries sector. Data was collected in Indonesia through interviews with various stakeholders and a questionnaire survey (N=148) completed by owners or senior managers of SMEs in the metal industry. In this paper we focus on the development, administration and results of the questionnaire survey. The survey results indicated that the small size of many SMEs, together with the low use of improvement tools and information technology, present challenges to successful implementation. However, questionnaire respondents were reasonably optimistic about the success of an innovation like Lean Six Sigma and reported encouraging levels of management and employee commitment to such a change. Respondents reported that they were most influenced by their key customers and by other SMEs when making a decision about adopting an innovation like Lean Six Sigma.

Keywords: Indonesia, Innovation Adoption, Lean Six Sigma, SMEs

INTRODUCTION

This paper presents key findings of a questionnaire survey of Indonesian small and medium size enterprises (SMEs) who compete in the metal sector. The survey was part of research project aimed at developing a framework for implementation of Lean Six Sigma in this industry sector. The research methodology for the project consisted of a questionnaire survey of a sample of SMEs operating in the metal sector, reported here, and interviews with stakeholders with an interest in SME development. For example, interviews were carried out with representatives from the Indonesian Business Development Services who provide support for SMEs, with SME owners and with customers of SMEs. The main purpose of the questionnaire survey reported here was to assess the readiness of SMEs in this sector for the introduction of an innovation like Lean Six Sigma and to gather information needed to contribute to the design of an effective implementation framework.

The paper first presents a literature review on Indonesian SMEs, Six Sigma and Roger's work on diffusion of innovations [16]. This is followed by an explanation of the design of the survey instrument, then the data collection procedures used and finally presentation of key survey results. A discussion of the results and conclusions end the paper.

LITERATURE REVIEW

Indonesian SMEs

Research has identified that SMEs have some characteristics that in general differentiate them from large organisations e.g. [10]. For example, the organisational structure of SMEs is usually much simpler than that of large organisations. Both day-to-day and strategic decisions in SMEs are more likely than in large organisations to be made by the leader, who is often the business owner. The structure and leadership of SMEs can provide them with better agility than large organisations to respond to change. However SMEs often lack the resources and the organisational slack of large organisations and this can impede their

competitive development, particularly business improvement and the adoption of innovations.

In Indonesia, SMEs play a vital role in the economy, and employ a substantial proportion of the workforce [4]. However, their export contribution is small compared to ASEAN (Association of Southeast Asian Nations) countries such as Singapore and Malaysia [19]. There is also concern that SMEs operating in the metal sector need to be more competitive on price, quality and delivery performance in order to compete effectively in their local market against strong foreign competitors such as China [20] [18].

Indonesian SMEs receive various forms of support, some internal and some external in the way of development aid projects. Indonesian government support has typically been in the form of training and financial loans. A summary of this support since 1969 has been made by Hayashi [25]. Non-government support comes from bodies such as universities, large organisations and is usually provided in the form of consultation, training and technical assistance [18].

Six sigma and lean six sigma

The Six Sigma concept was first introduced by Motorola Company in the mid 1980s. The central idea of this approach is to design processes, or improve existing processes, to obtain very high process capability and hence defect rates that are close to zero. A Six Sigma target defect rate of 3.4 defects per million components/incidents is often cited [7]. General Electric (GE), under the leadership of CEO Jack Welch did much to popularise the use of Six Sigma [15].

Since its inception a number of variants on the original concept have been developed, often combining Six Sigma with ideas from other improvement approaches [1] [3] [22]. Lean Six Sigma, perhaps the most popular variant of Six Sigma, integrates Six Sigma with Lean principles [13]. Lean Six Sigma is claimed to have some advantages over Six Sigma and is aimed at improving quality, reducing processing time and reducing production cost [2]. The Lean concept was first introduced by The Toyota Company [21] and is popular today particularly in some large organisations which have successfully integrated it with Six Sigma. According to advocates both concepts, Lean and Six Sigma, can be integrated to provide an agile approach in order to respond to the changes in customer wants, which have resulted from globalization pressures [2].

Six Sigma uses a systematic approach i.e. DMAIC (Define, Measure, Analyse, Improve and Control) to structure improvement projects. There are various analysis tools to aid in problem identification and improvement e.g. Pareto analysis and root cause analysis. A fascinating and successful development in Six Sigma has been the introduction of the 'belt system' used in training i.e. green belt, black belt and master black belt – presumably copied from martial arts. Recently, Harry and Crawford [12] introduced a 'white belt' designed to help small businesses by providing a more affordable alternative to the foundation green belt program. Six Sigma has attracted a moderate amount of attention from academics e.g. recently Schroeder et al. [17] have explored the theoretical basis of six sigma.

Information on four implementation frameworks specific to Six Sigma were found in the literature, these were by Chang [6], Park [14], Burton & Sams and Furterer [9]. None of these frameworks specifically addressed Lean Six Sigma implementation in SMEs but were of use in guiding the research.

Diffusion of innovation theory

The work on diffusion of innovations by Rogers [16] was used as the theoretical framework for the research. Roger's work on diffusion of innovations has been refined over many years and its application extended from focusing on adoption of new ideas by individuals to

adoption of new ideas by organisations. Consideration of the culture, at national, local, industry and individual levels, into which an innovation is introduced is a strong aspect of the theory. Rogers [16] argues that to enable successful adoption, innovations that are being transferred from one cultural setting to a different cultural setting should be suitably modified to fit in with the new setting. To support further discussion, Roger's core ideas on diffusion of innovation are now explained. Broadly speaking Rogers identifies two sets of variables related to the adoption and diffusion of innovations. The first set of variables relate to organisational innovativeness i.e. how receptive an individual organisation is towards the adoption of an innovation. The second set of variables relate to the rate of adoption of an innovation in a particular industry and cultural setting. It is evident that there is some linkage between the two sets of variables; they are not completely mutually exclusive.

The organisational innovativeness variables include the following:
a) Characteristics of the leader(s) in the organisation, especially their attitudes towards supporting new ideas in the organisation.
b) Characteristics related to the internal organisation structure: – *centralisation* according to Rogers [16, p.412] is '…the degree to which power and control in a system are concentrated in the hands of a relatively few individuals' – *complexity* is '…the degree to which an organisations' members possess a relatively high knowledge and expertise…' – *formalisation* is '…the degree to which an organisation emphasises following the rules and procedures in the role performance of its members' – *interconnectedness* is '…the degree to which the units in a social system are linked by interpersonal networks' and *organisational slack* is '…the degree to which uncommitted resources are available to an organisation'.
c) Lastly, *systems openness* which is an external characteristic of the organisation '…the degree to which the members of a system are linked to other individuals who are external to the system'.

According to Rogers [16] there are five main constructs that combine to determine the adoption success innovations:
1. Perceived attributes of the innovation consisting of areas: relative advantage, compatibility, complexity, trialability and observability.

Relative advantage is 'the degree to which an innovation is perceived as better than the idea it supersedes' [16, p.229]. Compatibility focuses on how compatible an innovation is with social and cultural values and beliefs, previously introduced ideas or client needs for the innovation. Complexity is 'the degree to which an innovation is perceived as difficult to understand and use' [16, p.257]. Trialability is 'the degree to which an innovation may be experimented with on a limited basis' [16, p.258]. Observability is 'the degree to which the results of an innovation are visible to others' [16, p.258]. Generally innovation have promising characteristic for diffusion when they are perceived as better than existing methods, are compatible with cultural values and beliefs in their intended setting, are not over complex, can be triald easily and where results can be made visible for scrutiny.

2. Type of innovation decisions; three types are identified by Rogers [16] namely individual-optional, collective and authority.
The point here is that it is important to understand who makes decisions related to the adoption of an innovation and the authority that these decision makers have in actioning their decisions. Individuals, or groups in an organisation may be the key decision makers or support for an innovation may occur at government level through for example an industry support structure.

3. Communication channels; the ways in which the message about the innovation is disseminated. There are a number of options depending available for different situations e.g. word of mouth, mass media, industry forums, demonstration plants. The ore effective the communication channels the more likely the innovation will diffuse through an industry.

4. Nature of the social system e.g. its norms, degree of network interconnectedness. Generally, the better an innovation fits into the cultural setting the more likely it is to succeed,

5. Extent of change agents' promotional efforts.

A change agent is 'an individual who influences clients' innovation decision in a direction deemed desirable by a change agency' [16, p.27]. As well as the selection of appropriate communication channels to publicise an innovation the change agents' promotional efforts are important because attitudes and behaviours of change agents (e.g. industry associations, government agencies) towards change usually depends on a real commitment to promoting an innovation.

METHODS

The target population for the research was SMEs from the metal sector in Pasuruan and Sidoarjo areas in the Province of East Java, Indonesia. The metal sector was chosen as it is composed almost entirely of SMEs and contributes significantly to the Indonesian economy. The sector is also well organised making access to data collection attractive for this kind of research being undertaken. The questionnaire was designed to be completed by the SME owner or a senior manager and was organised into five parts, A to E, as described below. Items on the questionnaire that required an evaluation used a 1 to 7 rating scale e.g. 1= very low to 7= very high. Some sections of the questionnaire had space for respondents to comment. The construction of the questionnaire was based on Roger's work described above with input from a number of other sources. For example, in part D of the questionnaire items were drawn from sources that included Flynn, Schroeder and Sakakibara [8]; Yusof [23] McAdam, Reid and Gibson [25] Hale and Cragg [11] and Burton and Sams [3]. The questionnaire was constructed as follows:

Part A. General Information e.g. company demographics, type of ownership, use of information technology.

Part B. Program use and Support. There were two sets of questions in part B. B1 - the degree of understanding and extent of use (two evaluations) of various types of management programs e.g. TQM, Six Sigma. B2 - the extent, and importance of various types of support e.g. from the Indonesian business development services, from universities, from significant customers and suppliers.

Part C. Understanding and use of Tools and Techniques. Respondents rated the degree of understanding and company usage of 25 improvement tools and techniques.

Part D. Readiness to Adopt Innovation. There were six sets of questions in part D: D1 – improvement culture; D2 – resource availability; D3 – Respondent's support for a new program; D4 – Employee's ability to contribute to new program; D5 – Training capacity to support a new program.

Part E. Influences and Expectations. The first section contains items to measure how important different types of organisation (e.g. other SMEs, government agencies, key customers) were in influencing the respondent's decision to adopt a new program. A single item measured the strength of the respondents belief that a new program (like Lean Six Sigma) would be successful in their organisation.

The questionnaire went through rigorous development, including pilot testing in Indonesia. There was the added challenge of developing the questionnaire in English and then producing a version in the Indonesian language. The initial data collection plan was to administer questionnaires at the SME's regular meeting and this strategy was approved by the meeting leaders. In parallel with direct data collection questionnaires would also be mailed to an additional sample of SMEs. Unfortunately, for reasons beyond the control of the researcher the plan to distribute questionnaires at the regular SME meeting had to be abandoned. Also, it was evident that the response rate from the questionnaires mailed out was not acceptable i.e. 200 mailed, 18 usable responses received; a response rate of only nine percent. These unexpected events led to an urgent re-evaluation of data collection strategy. It was decided that direct contact with SME owners and managers was the most effective way to achieve an acceptable sample of completed questionnaires. Face-to-face contact between the researcher and SME owners and senior managers was indeed found to be an effective way to get the questionnaires completed. However, the process was time consuming and extended the length of the fieldwork in Indonesia by several months.
A total of 148 usable questionnaires were eventually obtained representing approximately 21% of SMEs in the target industry sectors and geographical areas. The questionnaire data was analysed using the SPSS statistical package. Data reduction was carried out on the groups of variables in part D of the questionnaire using factor analysis. The extraction method used was principal component analysis and this was followed by varimax rotation. Internal reliability of each of the new variables was assessed by calculating values of Cronbach's alpha. The variables formed from this analysis, together with an explanation of their meaning and the values of Cronbach's alpha are presented and explained in Table 1 below. It can be seen that the values of Cronbach's alpha are quite robust. The items contributing to each of the new variables formed from factor anlaysis were examined to see if they made sense in forming a consistent group and this was deemed to be the case. These variables were therefore used with some confidence in subsequent analysis.

Table 1. Readiness Variables (Part D of questionnaire)

Variable Name	Explanation	Cronbach's alpha*
Use of improvement tools (4 items from section D1)	Extent of use of tools/techniques to improve quality, reduce cost, reduce production times. (These 4 items formed one group when subject to factor analysis)	0.91
Communication with customers (1 item from section D1)	Extent of regular communication with customers in order to fill their requirements.	n/a single item
Resource availability (5 items from section D2)	Extent to which company is able to provide resources (financial, technical assistance, employees etc.) to support a new program	0.84
Management commitment (5 items from section D3)	The extent to which the respondent (owner/manager) is willing to support a new program e.g. willingness to involve actively in the implementation phase, attend training, provide resource, etc.	0.88
Employee commitment (5 items from D4)	Respondent's assessment of employees' willingness to support a new program e.g. learning new things, solving problems, working as a team	0.76
Training capacity (3 items from D5)	Evaluation of company's ability to provide training for a new program.	0.90

*Cronbach's Alpha is a measure of internal reliability of a group of items, values > 0.7 are considered acceptable.

RESULTS

Demographics

Eighty percent of the 148 respondents were SME owners. Almost half of the SMEs in the sample were small, employing less than 10 people, 5% employed more than 50 people. Nearly all were locally owned. Only 4.1 percent of the SMEs had ISO 9001 or SNI (National Indonesian Standard) certification in place. Many respondents told the researcher that they thought that these certifications were not necessary for their business.

The use of Information Technology (IT) was low, most SMEs preferring to have direct meeting to their suppliers, buyers, etc. Only about seven percent of the SME were using IT actively to support their business.

Who influences SMEs?

Who do SME owners and managers take notice of when they make strategic decisions like implementing a new improvement methodology? This is a useful question to ask when planning an implementation strategy. The results presented in Table 2 suggest that all the entities listed are influential to some extent. However, SME's key customers and other SMEs are the most influential in guiding their decision making.

Table 2. Influences on SMEs technology decisions

Influencing Entity	Mean*	SD
Key customers	5.83	1.66
Other SMEs	5.35	1.89
Suppliers	4.60	2.31
University/institution	4.52	2.32
Business Development Services (BDS)	4.48	2.28
Government	4.22	2.24

*Measured on a scale from 1 (not influential) to 7 (very influential)

Readiness factors

As explained above part D of the questionnaire measured characteristics of the SME from the perspective of the owner or senior manager that are considered important in nurturing a new technology like Lean Six Sigma. Five composite variables were formed i.e. use of improvement tools, resource availability, management commitment, employee commitment and training capacity. An explanation of each of these variables is provided in Table 1. Table 3 below shows the mean and standard deviation for each of these variables (including the single item – communication with customers). The correlations between these variables is also shown. Note that the composite variable values are the mean of item values. The measurement scale used was from 1 (very low) to 7 (very high). For all of the variables high values are considered more supportive of a new technology than low values.

It can be seen in Table 3 that 'use of improvement tools' is very low (mean=2.35) while the means of the other variables are quite high. Note that correlations between variables 2 to 6 in Table 3 are positive and significant at the 0.01 level. There is only one positive correlation between 'use of improvement tools' and the other variables.

Table 3. Means, standard deviations and correlations between readiness variables

Variables	Mean	SD	Correlation				
			1	2	3	4	5
1.Use of improvement tools	2.36	1.72					
2.Comm. with customers	5.45	1.61	.20*				
3.Resource availability	4.36	1.54	-.18*	.32**			
4.Management commitment	5.54	1.45	-.22*	.37**	.62**		
5.Employee commitment	4.67	1.18	.00	.41**	.42**	.44**	
6.Training capacity	4.45	1.88	-.20*	.29**	.53**	.64**	.43**

* Correlation significant at the 0.05 level (two-tailed)
** Correlation significant at the 0.01 level (two-tailed)

Belief about the success of an innovation like lean six sigma

A single item measured the respondents level of optimism about the success of a new program: 'Please indicate on the scale below the extent to which you believe that implementing a new program/approach in your company such as TQM, Lean Six Sigma, etc. is likely to be successful.' The response to this question is shown in Figure 1. Of note is that just over of third of respondents gave an evaluation of 4 suggesting uncertainty – 'sitting on

the fence' -or perhaps lack of understanding of what these kind of initiatives mean for practice. However, on a positive note over one third of respondents returned optimistic evaluations of 5 and above.

We explored for variables that explained the degree of optimism of respondents using multiple linear regression. The dependent variable was the single item measurement of belief about success already described. The independent variables (predictor variables) used were as follows:

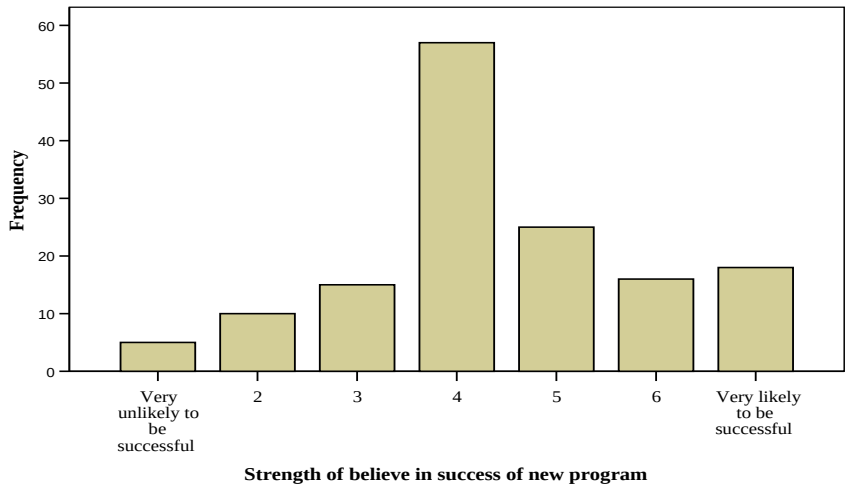
- The six readiness variables (see Table 1 for a list of these)

Plus the following 'control variables' which were entered as 'dummy variables':

- Market orientation (domestic/export)
- Company ownership – four options
- Product type – three categories
- Length of time company has been in business – four categories
- Number of employees - five categories
- Respondent to questionnaire (owner/senior manager/other)

A number of standard checks were made to assess the validity of the data for multiple regression e.g. for autocorrelation and collinearity. These tests supported the suitability of the data for this analysis. The results (using the enter method) identified two significant predictor variables i.e. employee commitment (std. Beta=0.207, p=0.051) and resource availability (std. Beta=0.190, p=0.039). The overall regression model was significant (F=2.97, p<0.01, R^2=0.34).

Figure 1. Belief that a new program will succeed



DISCUSSION AND CONCLUSION

The paper has presented the development and some key results of a questionnaire survey designed to help evaluate the readiness of Indonesian SMEs to adopt a new innovation like Lean Six Sigma. The information will be used to help develop a framework to implement Lean Six Sigma.

The demographics of the targeted SME sector suggest some challenges in implementing an innovative improvement method. There are a large proportion of very small companies with less than ten employees and generally across the sample there is low use of information technology and improvement tools. So considering Roger's criteria for the acceptance and diffusion of an innovation, discussed in the literature review, there are clearly some challenges in relation to Six Sigma. Some aspects of Six Sigma are relatively complex compared to the levels of expertise revealed by the survey results e.g. level of statistical knowledge required. However, there is a distinct note of optimism in the data as over a third of responding SME owners/managers believe that the introduction of an innovation like Lean Six Sigma into their organisation could be successful. Also, with the exception of 'use of improvement tools' the mean values of the readiness variables (see list in Table 3) are 'positive' i.e. greater than 4 on the 1 to 7 agreement scale. Furthermore, the SME sector in Indonesian receives government support from Business Development Services.

The results presented are also useful in formulating an implementation strategy. For example results suggest that SME owners/managers are most influenced in their strategic decision making by their key customers and other SMEs. Identifying SMEs who have the capacity and motivation to be pioneers in implementing Lean Six Sigma and are also enthusiastic about assisting other SMEs could be an effective part of an industry implementation strategy. This approach of setting up pilot sites to try out new technology has already been used with other innovations such as TQM.

The two variables that appear to most influence owner/manager optimism about the success of a new innovative were their evaluations of employee commitment and resource availability in their organisations. Employees' willingness to work as a team, to learn new things and solve problems in the workplace is undoubtedly a major factor in the ability of an SME to adopt new ideas and improve. To be able to finance and support a new initiative where training and equipment costs have to be met is clearly also a significant issue for SMEs.

The results presented here provide a useful source of information for designing an implementation framework. There are of course some limitations in the data collected via the questionnaire survey. The evaluations are from the SME owner/manager perspective; employees at lower levels were not surveyed. We believe the sample size is sufficiently large to conduct meaningful analysis, although the sample may not be truly representative of the target population of SMEs. Other data collected during the research through interviews with other stakeholders will be used to supplement the questionnaire survey results.

REFERENCES

[1] Arnheiter, E.D. & Maleyeff, J. 2005. The integration of lean management and six sigma, *TQM Magazine*, vol.17, No.1, pp.5-18.

[2] Basu, R. & Wright, N. 2003. *Quality beyond Six Sigma*, Elsevier Butterworth Heinemann, Oxford.

[3] Burton, T.T. & Sams, J.L. 2005. *Six Sigma for small and mid-sized organizations*. Florida, J. Ross Publishing.

[4] Central Bureau of Statistics, 2005. Jumlah Penyerapan Tenaga Kerja Usaha Kecil, Menengah dan Besar Menurut Sektor Ekonomi Tahun 2000 - 2003, Badan Pusat Statistik. Retrieved April 19, 2005 from http://www.bps.go.id

[5] Coronado, R.B. & Antony, J. 2002. Critical success factors for the successful implementation of six sigma projects in organizations, *The TQM Magazine*, vol.14, no.2, (2), pp.92-99.

[6] Chang, T.L. 2002. *Six Sigma: a framework for small and medium sized enterprises to achieve total quality*. Unpublished doctoral dissertation. Ohio, Cleveland State University.

[7] Evans, J.R. & Lindsay, W.M. 2008. *Managing for quality and performance excellence*, 7th ed. South Western, Thomson.

[8]Flynn, B.B., Schroeder, R.G. & Sakakibara, S. 1994. A framework for quality management research and an associated measurement instrument, *Journal of Operations Management*, vol.11, no.4, pp.339-366.

[9] Furterer, S.L. 2004. *A framework roadmap for implementation lean six sigma in local government entities*. Unpublished PhD dissertation. Orlando, University of Central Florida.

[10] Ghobadian, A. & Gallear, D. 1997. TQM and organization size, *International Journal of Operations & Production Management*, vol.17, no.2, pp.121-153.

[11] Hale, A. & Cragg, P. 1996, Business process reengineering in the small firm: a case study, *INFOR*, vol.34, no.1, pp.15-29.

[12] Harry, M.J. & Crawford, D. 2004. *Six Sigma for the Little Guy*, Mechanical Engineering Magazine. Available from: <http:// www.memagazine.org/emnov04/sixsigma/sixsigma.html>. Accessed 26 July 2005.

[13] Hines, P., Holwe, M. & Rich, N. 2004. Learning to evolve: A review contemporary lean thinking, *International Journal of Operations & Production Management*, vol.24, no.10, pp.994-1011.

[14] Park, S. 2003. *Six Sigma for quality and productivity promotion*. Tokyo, Asian Productivity Organization.

[15] Raisinghani, M.S., Ette, H., Pierce, R., Cannon, G & Daripaly, P. 2005. Six Sigma: concepts, tools, and applications, *Industrial Management & Data Systems*, vol.105, no.4, pp.491-505.

[16] Rogers, E.M. 2003. *Diffusion of Innovations*. New York, Free Press.

[17] Schroeder, R.G., Linderman, K., Liedtke, C. & Choo, A.S. 2008, Six Sigma: definition and underlying theory', *Journal of Operations Management*, vol.26, no.4, pp.536-554.

[18] Tambunan, T. 2006. Technology transfer and diffusion among manufacturing small and medium sized enterprises in Indonesia, *The Copenhagen Journal of Asian Studies*, vol.24, pp.105-136.

[19] United Nations Trade and Development Board. 2003, Improving competitiveness of SMEs through enhancing productive capacity, *United Nations Conference on Trade and Development*, Geneva.

[20] Urata, S. 2000. *Outline of tentative policy recommendations for SME promotion in Indonesia*, JICA, Jacarta.

[21] Womack, J.P., Jones, D.T. & Ross, D. 1984. *The machine that changed the world.* Canada, Collier Macmillan.

[22] Yeung, Shirley M.C. 2007. Integrating ISO 9001:2000 and six sigma into organisational culture, *International Journal of Six Sigma and Competitive Advantage*, vol.3, no.3, pp.210-227.

[23] Yusof, S.M. 2000. *Development of a framework for TQM implementation in small businesses*, PhD thesis, University of Birmingham, Birmingham.

[24] McAdam, R., Reid, R.S. and Gibson, D.A. 2004. Innovation and organisational size in Irish SMEs: an empirical study, International Journal of Innovation Management, vol.7, no.3, pp.147-165.

[25] Hayashi, M. 2003. *Development of SMEs in the Indonesian economy*, Working papers in trade and development no.2003/01, ANU, Canberra.